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PARKA-II (EARS-III) BOTTOM LOSS MEASUREMENTS, TRIP REPORT.(U)

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NAVY UNDERWATER SOUND LABORATORY
NEW LONDON, CONNECTICUT 06320

PARKA-II (EARS-III) BOTTOM LOSS MEASUREMENTS, TRIP REPORT

by

S. R. Santaniello

NUSL Technical Memorandum No. 2211-2-70 NUSL-TM-

12 January 1970

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INTRODUCTION

The Navy Underwater Sound Laboratory in conjunction with Lamont-Doherty Geological Observatory of Columbia University, conducted bottom loss measurements under the PARKA II experiment, at the proposed site for the SPIDER Array, north of Hawaii. These measurements were conducted during two separate cruises from 14 to 25 September and 1 to 8 November 1969. The source ship (R/V CONRAD) detonated 500 and 11,000 foot explosives and the receiving ship (USNS SANDS T-AGOR-6) used a single hydrophone suspended to approximately 11,000 ft. This memorandum discusses these cruises.

HISTORY

The PARKA-II Bottom Loss Measurements (P-BL) were originally scheduled to be conducted using the SPIDER Array. The R/V CONRAD and USNS SANDS were to be the source and receiving ships, respectively. Difficulties were encountered during the first SPIDER implantment, which resulted in a block of time (14-25 September) for which the CONRAD and SANDS had to be employed. It was considered best to utilize this time to conduct modified bottom loss measurements at the SPIDER site. The CONRAD would detonate explosives as originally planned in Reference 1, but the SANDS was to use the NUSL Two-Hydrophone Array suspended from a spar buoy. The two hydrophones were to be positioned at 11,000 ft with a 1,000 ft separation.

This eleven day period of time was considered sufficient (under normal weather conditions) to conduct the desired measurements as outlined in Reference 2. However, two difficulties were encountered during the operations that did not allow the completion of the P-BL measurements as planned; (1) the NUSL Two-Hydrophone Array did not

function properly and it was necessary to conduct measurements using only one hydrophone suspended to 11,000 feet, and (2) the CONRAD was only able to detonate the 500 ft explosives, because proper materials (TNT blocks and boosters) had not arrived aboard by the re-scheduled sailing date. The quality of the low grazing angle bottom loss data, obtained using the shallow explosives, was therefore not of the quality expected if deep explosives (11,000 ft) had been used. The reason for this is covered in the discussion of this report. Therefore, during the first period from 14 to 25 September the P-BL data obtained was with a single hydrophone suspended from the SANDS to 11,000 ft and for 500 ft explosives. The SANDS held station as the CONRAD traversed three tracks (0, 60, 240 degrees true from SANDS) to a distance of 80 kyds, detonating the explosives at predetermined intervals.

A second attempt to implant the SPIDER Array also failed and an additional block of time (1-8 Nov) became available to conduct the P-BL measurements using the deep explosives. The CONRAD and SANDS were again employed in a joint effort to conduct the measurements, and the SANDS suspended only a single hydrophone to 11,000 feet.

The second operations (Reference 3) were to be conducted in a similar manner as for the first cruise, where the CONRAD was to traverse each of the three tracks and detonate explosives at a predetermined interval. However, three difficulties arose that modified the operations: (1) for the second cruise it was far more difficult to position the SANDS, than for the first cruise, because for the second cruise the SPIDER surface (reaction) buoy was not available for positioning (Figures 4 and 5, cruise "Positioning Charts"), (2) the type explosives used raised questions as to the accuracy of depth of detonation, since the free fall time of the explosives from entry into the water to detonation varied from 14 to 21 minutes, and (3) one out of four explosives successfully detonated.

The ability to conduct the type operation outlined in Reference 3, (i.e., with a predetermined detonated rate as the ship traverses a fixed track) is severely hampered with a high "dud" rate for the explosives. The operations were therefore modified such that the CONRAD took up station at fixed ranges and dropped five (5) explosives every five (5) minutes. Thus data was acquired at a fixed grazing angle. Because of the high dud rate there is no statistical significance to the limited amount of data acquired.

Unfortunately, weather conditions worsened during the second cruise causing the cancellation of operations for the final two days. Partial data was acquired over only one track, 0 degrees true from SANDS.

PERTINENT FACTS

Purpose of Measurements

To provide bottom loss acoustic measurements at the immediate SPIDER site for incorporation into the PARKA-II propagation loss model. To institute operational, processing and analysis procedures for bottom loss and distortion measurements in support of future NUSL EARS Cruises.

Objectives

To conduct bottom loss measurements using two ships, deep (10,000 ft) explosives and a deep multi-hydrophone array such that the direct and first order bottom reflected acoustic paths can be compared for both loss and distortion. To study effects of additional multi-reflected acoustic paths using a comparitive measurement approach. To conduct these measurements over the frequency range from below 100 Hz to 5,000 Hz. To institute and incorporate shipboard on-line computer processing using the UNIVAC 1230 computer. To relate the acoustic results to theoretical models based onthe structure and composition of the ocean bottom under study.

NUSL Participating Personnel (Cruise 1)

Salvatore R. Santaniello (Project Leader)
Thomas A. Bender (Coordinator)
Arthur L. Moorcroft (Unit Leader)
Clair J. Becker (Unit Leader)
Robert B. MacDonald
Harold J. Ware
Laurier L. Collin
Gary T. Griffin
David M. Potter
Charles C. Doherty
Steven R. VanDerVeen
Rudy J. Valentine
Frank Woods (UNIVAC Representative)

NUSL Participating Personnel (Cruise 2)

Salvatore R. Santaniello (Project Leader)
Thomas A. Bender (Coordinator)
Arthur L. Moorcroft (Unit Leader)
Clair J. Becker (Unit Leader)
Harold J. Ware

David M. Potter
Stanley C. Jackson
William M. Matejek
Frank C. Walsh
Frank Woods (UNIVAC Representative)

DISCUSSION

Justification for 11,000 Ft Explosives

To properly describe the reflection process at the ocean bottom, it is necessary to insure separation in time between a bottom reflected acoustic pulse and any acoustic pulse propagating over another major water path. Regardless of measurement technique (absolute or comparative) little confidence can be given to bottom reflectivity when it is known that the reflections analyzed contain a number of major water paths of different acoustic levels. In order to insure the desired separation for all grazing angles, it is usually necessary to conduct bottom reflection and distortion measurements using two ships, deep projector (explosives) and deep hydrophone(s). To obtain proper bottom loss results for the PARKA studies, specifically for low grazing angles and at the desired frequencies, deep explosives had to be used.

Prior to the P-BL measurements, acoustic ray tracings were generated by the NUSL UNIVAC 1108 computer using the "CONGRATS" (Ref 4) ray tracing program. This was done using the velocity profile for the area and time of year of the measurements and for the two different geometric arrangements to be used; i.e. for 500 foot and 11,000 foot explosives (source) and an 11,000 ft receiving hydrophone. For the shallow source case, the computer generated path structure was not uniform. Because of the proximity of the water surface, and because the velocity profile has a slight positive slope near the surface, there occurred a shadow zone with respect to the directly propagated path (i.e. non-reflected) at a range corresponding to 10 degrees grazing for the bottom reflected path. At ranges around this, there were as many as four "direct" paths due to refraction. When considering actual data acquisition where the explosive pulse would have some finite pulse length, for all cases studied around 10 degrees grazing for the reflected pulse, the "direct" path pulse would consist of a direct and surface reflected pulse. For low grazing angles these two paths are inseparable. This leads to the problem of combining the energy of pulses that are not of equal strength. The same condition of energy combination, arises in measurement of the bottom reflected pulse. For the shallow explosive the bottom reflected path is actually a bottom reflected and surface-bottom reflected combination of paths. This leads to difficult, if not impossible analysis, for both the comparative and absolute measurement of the bottom loss.

There is another restriction to the usefulness of near surface explosives. The pulse duration, due to bubble pulse and scattering, is nominally in the order of 200 milliseconds and at low grazing angles the "direct" pulse will mesh with the bottom reflected pulse. In general, it can be seen that the above restrictions limit the meaningfulness of bottom loss data using shallow explosives and/or hydrophones to angles from 17 to 12 degrees grazing depending on the actual geometry, velocity gradient and water depth.

When sufficiently deep projector (explosives) and hydrophones are used bottom loss measurement become more meaningful. The ray tracings for the second geometric arrangement analyzed showed uniform and well behaved acoustic path structures over the entire range of grazing angles of the bottom reflected path. These studies showed that for the actual broad band explosive pulse a grazing angle of close to one degree could be obtained (separation of 10 milliseconds between direct and reflected paths). However, the limit in low reflection angle coverage is also dependent upon the band limit restrictions of the processing.

Cruise 1 Data Acquisition

The shipboard acquisition and processing of the 500 ft, 3 lb explosive, bottom loss data for the first cruise (14-25 Sep) follows the block diagram of Figure 1. All data was broad band recorded on an analog tape recorder using dual gain channels. The recordings were FM at 15 ips limiting the band to 5000 Hz. One channel was prefiltered to isolate the 3200 to 4200 Hz band for possible comparison with MGS bottom loss results. Also data for one analog channel was filtered through a 75 Hz high-pass filter. This data could be used for analysis above 75 Hz if the low frequency cable noise distroyed the broad band data. Additional analog recordings were made for (1) Voice, (2) Time Code and (3) Blast Tone.

The hydrophone receptions were also band limited through a 1000 Hz low pass filter and fed to the input of the multi-verter for the UNIVAC 1230 Computer System. This was done to limit the data to the band expected for the SPIDER array and also because it was the major band of interest for the PARKA studies. These low pass 1000 Hz instantaneous signals were digitized for possible FFT processing off-line at a later date.

The broad band signals from the hydrophone were also processed through a set of 1/3 octave filters and detector averaged. As indicated in the block diagram, the filters were centered at 50, 100, 200, 400, and 800 Hz and were detector averaged using 20, 10, 10, 5, and 5 msec. time constants respectively. The envelope detected data were digitized

simultaneously with the 1000 Hz broad band data by the UNIVAC 1230 Computer System. The sample rate is indicated on the block diagram.

A calibration was made for the LM-2 ser: 227 hydrophone with cable, where an oscillator was placed across the 100 ohm "cal" resistor of the hydrophone and the frequency response was taken at the output of the cable. This response is shown in Figure 2. The gain setting of the main amplifiers used from the output of the cable to the input of channel-2 of the analog tape recorder was logged for each reception of data. All other amplifiers were maintained at a fixed gain and the value is indicated in the block diagram.

A set of six tables (Tables 1 through 6) presents the pertinent logging for the opening and closing runs along each track giving the shot number, the analog channel-2 gain setting and other appropriate information and remarks.

Since the SPIDER "reaction buoy" was still implanted during Cruise 1, it was possible for the SANDS to maintain excellent positioning. This is demonstrated by Positioning Chart-1 (Figure 4) where the shaded area indicates the position maintained by the SANDS during the acquisition of data for Cruise 1.

Cruise 2 Data Acquisition

The shipboard acquisition and processing of the bomb shot bottom loss data for the second cruise (1-8 November) follows the block diagram of Figure 3. As previously stated, the second cruise was conducted using 11,000 foot explosives. Since the peak spectrum for the 11,000 ft, 3 lb explosives is approximately 350 Hz, it was necessary to filter and amplify frequencies below 200 Hz for both analog and digital recordings.

All data was broad band recorded using dual gain FM channels, at 15 ips, limiting the band to 5000 Hz. The broad band signals were also processed through a 200 Hz low pass filter, amplified and recorded for possible comparison with MGS results.

For the digital recordings the broad band instantaneous signals were passed (1) through a 1000 Hz low pass filter to the UNIVAC 1230 multi-verter, and (2) amplified and fed into the 400 and 800 Hz 1/3 octave filters. The signals that were processed through the 200 Hz low pass filter for the analog recordings, were further amplified and fed into the 50, 100 and 200 Hz 1/3 octave filters and into a 63 Hz one octave filter. The output of all filters were detector averaged and digitized simultaneously with the instantaneous broad band signals. The time constants for the detectors and the digital sampling is

indicated on the block diagram. All fixed gain amplifier settings are also indicated on the block diagram.

The LM-2 hydrophone ser 277, was also used during the second cruise. Table 7 presents the gain settings for the master amplifiers and pertinent logged data for the limited number of explosives that were successfully detonated. Since the SPIDER "reaction buoy" was retrieved prior to the commencement of the second cruise, it was difficult to position the SANDS. The approximate position and bearing of the SANDS for each station (in relationship to the position of the SANDS during the first cruise) is also logged in Table 7 and is plotted in "Positioning Chart 2" (Figure 5).

SUMMARY AND PRELIMINARY OBSERVATIONS

Bottom loss data were obtained at the proposed SPIDER Array site in the Pacific using a single hydrophone suspended to 11,000 ft from the USNS SANDS (T-AGOR-6). The SANDS held station while the R/V CONRAD opened and closed range along three tracks (0, 60 and 240 degrees true from SANDS), while detonating explosives. The data were acquired during two cruises: Cruise-1, 14 to 25 September and Cruise-2, 1 to 8 November. Five hundred (500) foot explosives were used during Cruise-1 and the 11,000 ft explosives were used during Cruise-2. Cruise-2 occurred because the CONRAD was not able to detonate the deep explosives during Cruise-1 (lack of proper materials). However, for the second cruise the "dud" rate was large, where only 22 of 71 explosives were fired successfully. The second cruise was also aborted because of bad weather. This limited amount of data is considered marginal and not statistically significant but has been used to arrive at some preliminary conclusions.

The acoustic characteristic of an 11,000 ft explosive allows preliminary analysis for determining the location in depth of the major sub-bottom reflecting layer. The deep explosive has a duration of approximately 5 milliseconds. A detector averaging process was used on the broad band signal in such a manner that the direct arrival was made to appear Gaussian. The broad band bottom reflected signals for the 22 good explosives were then processed through this averager and the following observations were made. (It should be realized that the peak spectral energy for the 11,000 ft explosives is 400 Hz).

a. For signals that reflected at a grazing angle of 20 degrees or greater, the major energy within the reflection appeared to be from a sub-bottom layer in the order of 170 ft deep. This value is the average of analysis of 17 of the 22 good receptions. The depth was determined by using a simple "Braggs" relationship and by measuring the time difference between the reflection off the water sediment interface and the

reflection off the layer. Attenuation and refraction were not considered.

b. For angles below 20 degrees grazing the water sediment interface and layers at approximately 34 and 90 ft appeared to reflect the majority of energy. However, analysis of the instantaneous signal reflections, as viewed on an oscilloscope, indicates that an angle of "intromission" occurs at approximately 10 degrees grazing. This was indicated in two manners; (a) very small amount of energy being reflected for the data at 10 degrees grazing, and (b) a very dominant 180 degrees phase reversal for the instantaneous signal reflected from the water-sediment interface at 6 degrees grazing, along with a build-up in reflected energy. This is a classic indication of an angle of intromission and demonstrates that the sound velocity for the immediate sediment is lower than the sound velocity of the water just above the interface.

These acoustically determined sub-bottom layer depths have been supported by J. Ewing (Lamont) from a cursory study of the 3.5 kHz fathometer profiles. Ewing reported that a weak reflector (probably ash) was noted at approximately 25 feet with a strong reflector (for the 3.5 kHz signals) at approximately 70 feet deep (conjectured to be a solidified material). The profiler records showed "basement" to be in the order of 230 feet deep which is slightly deeper than what was determined acoustically. This discrepancy can be attributed to the approximations made in observations and calculations, and in the estimates for the grazing angle used for the acoustic calculations. However, it appears that a deep strong reflecting sediment layer (in the order of 200 ft) controls the reflection process for acoustic signals below 1000 Hz, in the area of the SPIDER site.

Salvatore R. Santaniello
SALVATORE R. SANTANIELLO
Senior Project Engineer

REFERENCES

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2. NUSL Memorandum Ser 2211-268 of 11 September 1969 "PARKA-II/EARS-III Bottom Loss Measurements Using NUSL Two-Hydrophone Array System; Operations Plan" by S.R. Santaniello.

3. NUSL Memorandum Ser 2211-303 of 22 October 1969 "PARKA-II/EARS-III Bottom Loss Measurements Using Deep Explosives; Operations Plan" by S.R. Santaniello.

4. NUSL Report No. 829 of 16 June 1967, "A Continuous Gradient Ray Tracing Technique" by H. Weinberg.

NUSL Tech Memo
2211-2-70

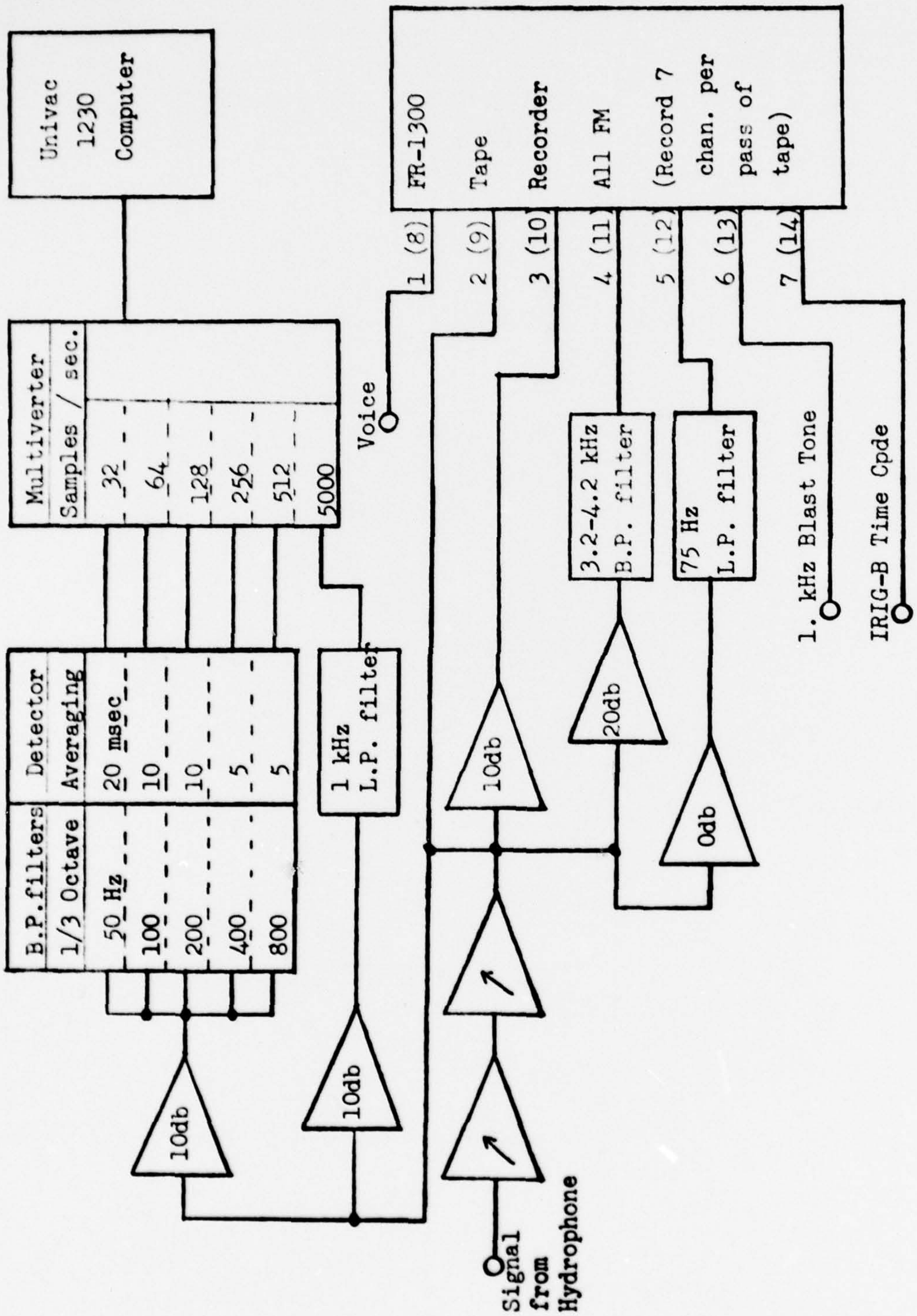

Figure 1
DATA ACQUISITION BLOCK DIAGRAM CRUISE-1
PARKA-II/EARS-III BOTTOM LOSS MEASUREMENTS

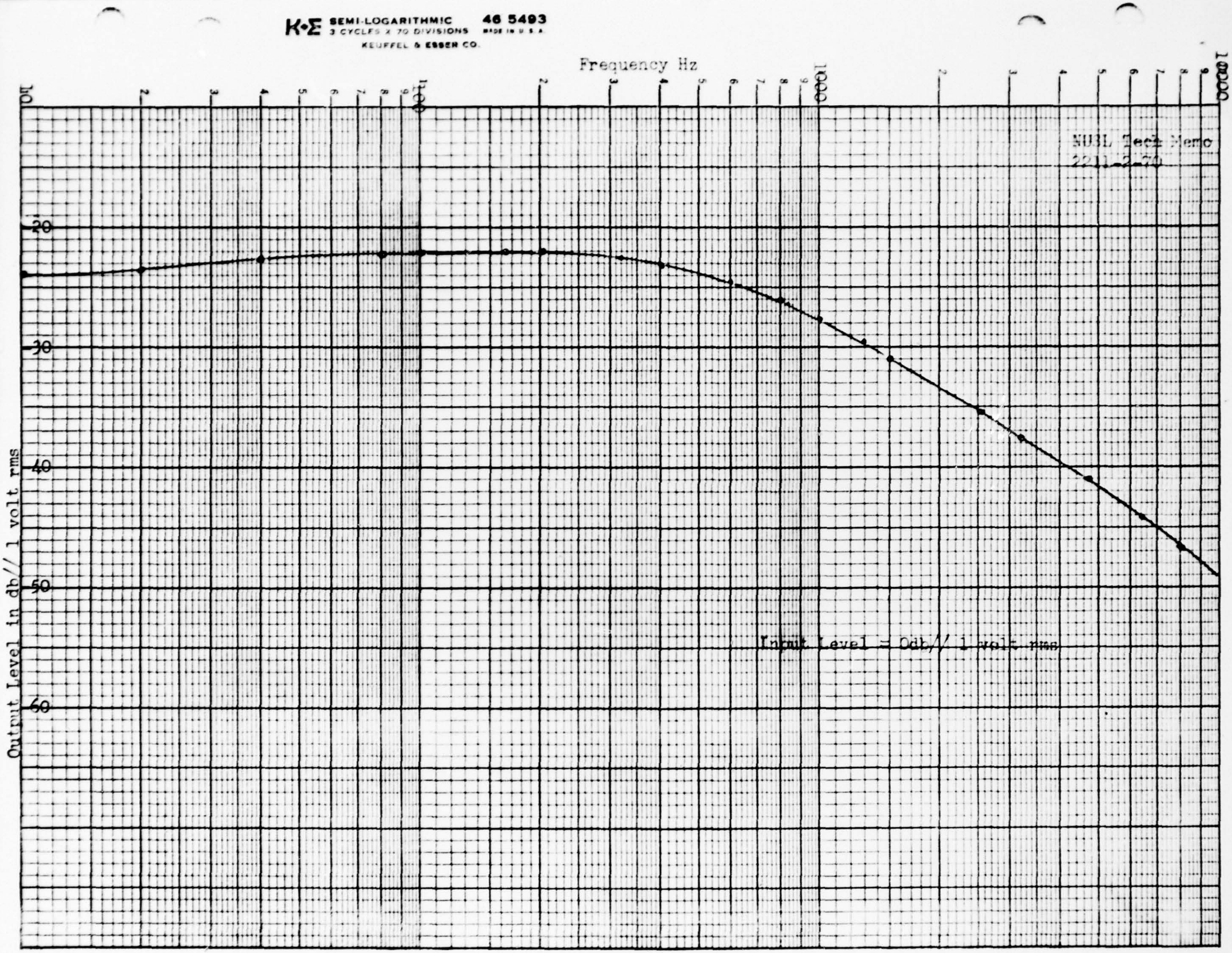

Figure 2 - FREQUENCY RESPONSE LM-2 SER 227 HYDROPHONE WITH 26,000 FT .219 HYDROPGRAPHIC CABLE

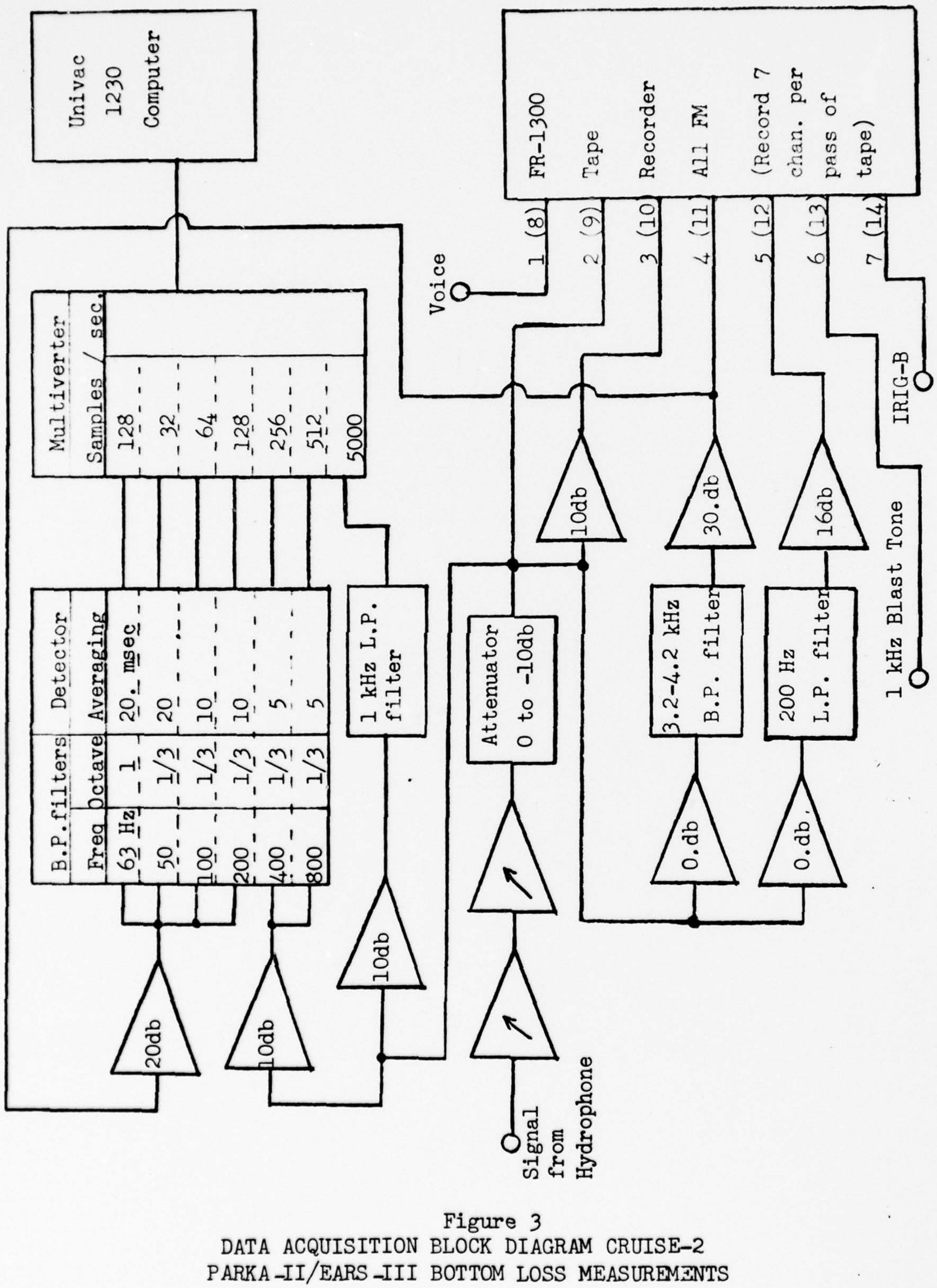

Figure 3
DATA ACQUISITION BLOCK DIAGRAM CRUISE-2
PARKA-II/EARS-III BOTTOM LOSS MEASUREMENTS

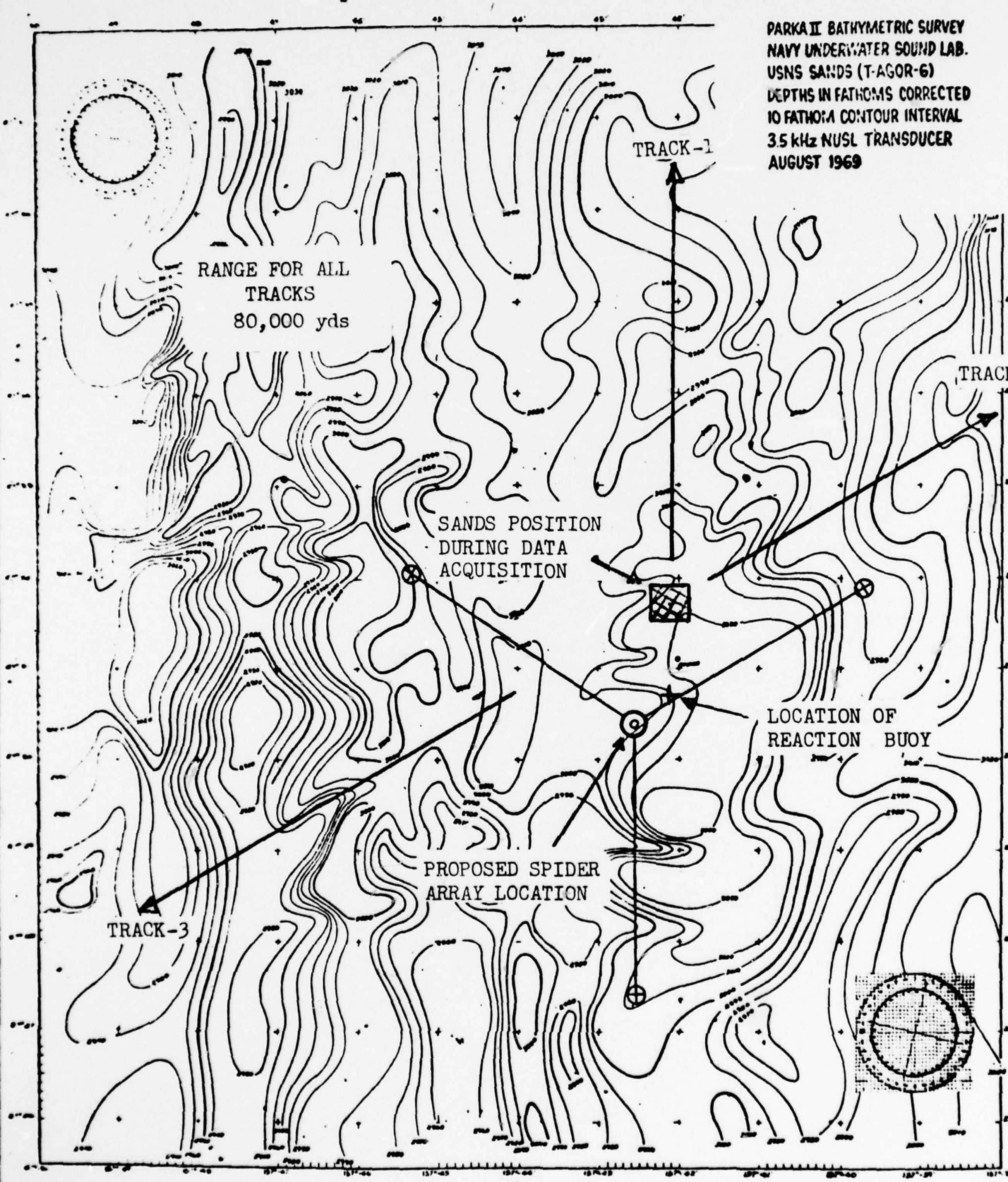

Figure 4

POSITIONING CHART-1 FOR CRUISE-1
PARKA-II/EARS-III BOTTOM LOSS MEASUREMENTS

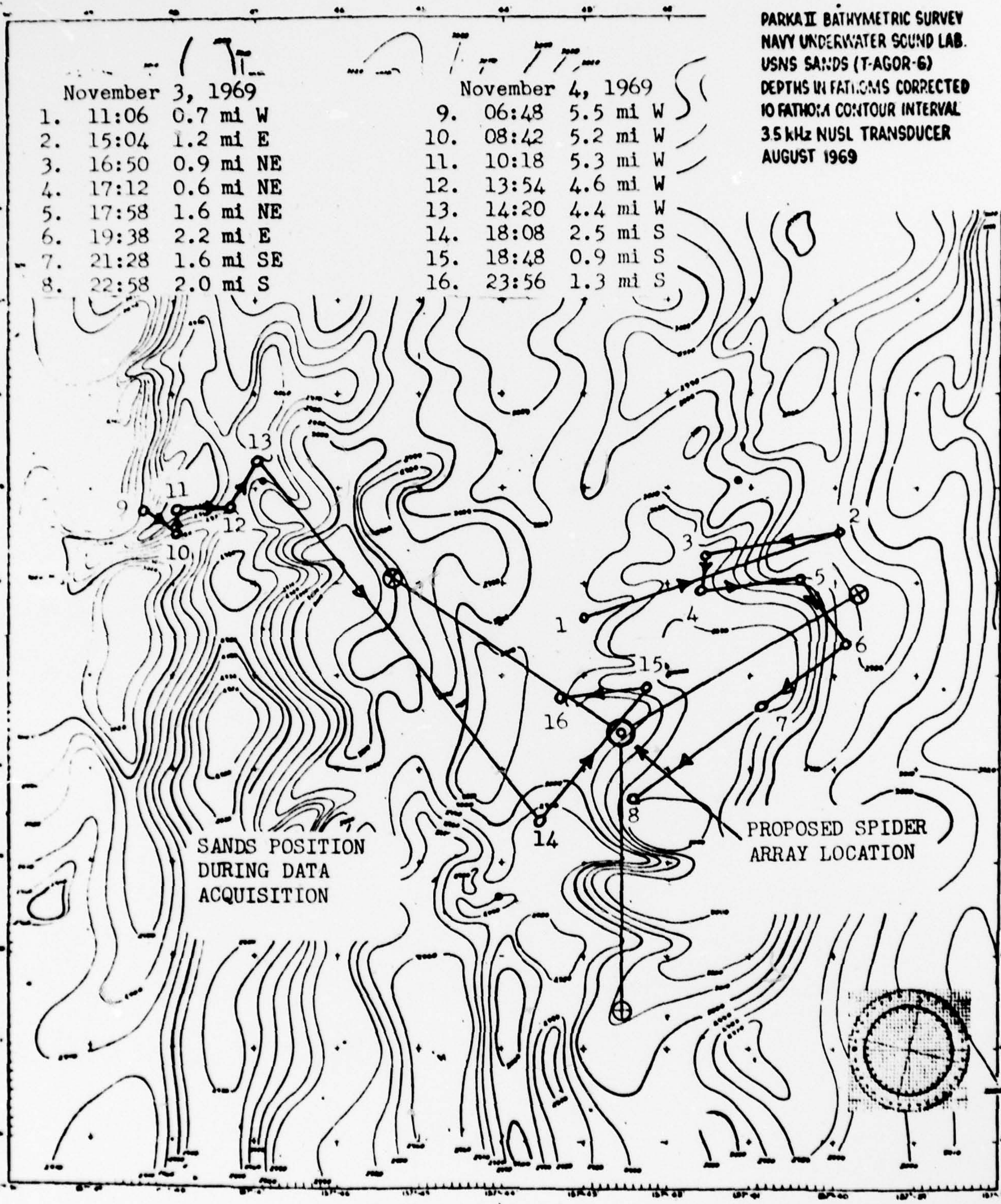

Figure 5

POSITIONING CHART-2 CRUISE-2
PARKA-II/EARS-III BOTTOM LOSS MEASUREMENTS

TABLE 1

Track-1 Opening

Bearing 0 Degrees True

Shot No.	Analog Tape No.	CH-2 Gain db	Digital Tape No.	CONRAD SOA knots	Shot Size lbs.	REMARKS
1	5A	22	2	4.5	2	CAP
2-4						GOOD
5						DUD
6-10						GOOD
11-14		25				GOOD
15				9		GOOD
16						MISSED (Tape Change)
17-20	6A					GOOD
21-26		35				GOOD
27-29			3			GOOD
30-33		41				GOOD
34-35	7A					GOOD
36			4		3	GOOD
37-41		38				GOOD
42-44						CAP
45						GOOD
46						GOOD Range 30,000 yds
47						GOOD
48						MISSED (no bang-box tone)
49-51						GOOD
52		48				GOOD Range 35,400 yds
53						GOOD
54-59		54				GOOD

TABLE 1 (cont)

Shot No.	Analog Tape No.	CH-2 Gain db	Digital Tape No.	CONRAD SOA knots	Shot Size lbs	REMARKS
60		64				GOOD
61						CAP
62						GOOD Range 43,600 yds
63-64						CAP
65-69						GOOD
70-75	8A	44	5			GOOD
76						CAP
77-78						GOOD Range 60,000 yds
79-84						GOOD
85-88		50				GOOD
89		56				CAP
90-92						GOOD

TABLE 2

Track-1 Closing

Bearing 0 Degrees True

Shot No.	Analog Tape No.	CH-2 Gain db	Digital Tape No.	CONRAD SOA knots	Shot Size lb.	REMARKS
1-10	9A	58	15	9	3	GOOD Range 76,000 yds
11-14		52				GOOD
15		49				GOOD
16			16			GOOD
17		46				GOOD
18-23		40				GOOD
24		36				GOOD
25						DUD
26						GOOD
27						CAP
28-36						GOOD
37-38	10A					GOOD
3942						CAP
43					2	CAP
44-45						GOOD
46						CAP
47-52						GOOD
53-61			17			GOOD
62-65						CAP
66						GOOD
67-68						CAP
69						GOOD
70						CAP

TABLE 2 (cont)

Shot No.	Analog Tape No.	CH-2 Gain db	Digital Tape No.	CONRAD SOA knots	Shot Size lb.	REMARKS
71						GOOD
72				4.5		CAP
73						PARTIAL
74						GOOD
75-76						CAP
77-78						GOOD
79						CAP
80-81						PARTIAL
82						GOOD
83		32				DUD
84						PARTIAL
85						GOOD

TABLE 3

Track-2 Opening

Bearing 60 Degrees True

Shot No.	Analog Tape No.	CH-2 Gain db	Digital Tape No.	CONRAD SOA knots	Shot Size lbs	REMARKS
1	11A	32	17	4.5	2	PARTIAL
2						GOOD
3		30				GOOD
4-5						GOOD
6						PARTIAL
7-12			18			GOOD
13						CAP
14				9		GOOD
15-20						GOOD
21						CAP
22-23						GOOD
24-26		33				GOOD
27						CAP
28						GOOD
29						CAP
30-31						GOOD
32		36				GOOD
33						CAP
34-40						GOOD
41						CAP
42-43						GOOD
44-53			19			GOOD
54-56		42				GOOD

Table 3 (cont)

Shot No.	Analog Tape No.	CH-2 GAIN db	Digital Tape No.	CONRAD SOA knots	Shot Size lb.	REMARKS
57		48				GOOD
58						CAP
59-62						GOOD
63					3	GOOD
64						CAP
65						GOOD
66						CAP
67						GOOD
68		45				GOOD
69		42				CAP
70		39				CAP
71-72						GOOD
73		42				GOOD
74						CAP
75						GOOD
76						PARTIAL
77						GOOD
78		45				GOOD
79						CAP
80			20			GOOD
81	12A					CAP
82-83						GOOD
84-85						PARTIAL
86						CAP
87						PARTIAL
88-91		55				PARTIAL

Table 3 (cont)

Shot No.	Analog Tape No.	CH-2 Gain db	Digital Tape No.	CONRAD SOA knots	Shot Size lbs	REMARKS
95	|	|	|	|	|	DUD
96	|	|	|	|	|	GOOD

TABLE 4

Track-2 Closing

Bearing 60 Degrees True

Shot No.	Analog Tape No.	CH-2 Gain db	Digital Tape No.	CONRAD SOA knots	Shot Size lb.	REMARKS
1-6	4B	53	7	9	3	GOOD Range 69,900 yds
7						GOOD Range 60,000 yds
8						CAP
9						GOOD First shot showing direct path
10						CAP
11-15						GOOD
16						PARTIAL
17					3	CAP
18-19						GOOD
20						CAP
21-22						GOOD
23	5B					GOOD
24-26		47				CAP
27-28						GOOD
29		41				CAP
30						GOOD
31-32						CAP
33						PARTIAL
34-35					3	CAP
36-43			8			GOOD
44-47						CAP
48						PARTIAL
49-50					3	GOOD

Table 4 (cont)

Shot No.	Analog Tape No.	CH-2 Gain db	Digital Tape No.	CONRAD SOA knots	Shot Size lb.	REMARKS
51						CAP
52						GOOD
53						Missed No Bang-Box Tone
54						GOOD
55						PARTIAL
56-57					3	GOOD
58						PARTIAL
59						GOOD
60-64		34				Radio Interference
65						CAP
66						GOOD
67						PARTIAL
68					3	DUD
69						PARTIAL
70-72						CAP
73						PARTIAL
74-76			9			CAP
77						GOOD
78-80	6B					CAP
81						GOOD Holding range at 81000 yds
82-83						PARTIAL
84						GOOD
85-86						PARTIAL
87-90						GOOD
91-92						GOOD
93		31				PARTIAL
94						GOOD

TABLE 5

Track-3 Opening

Bearing 240 Degrees True

Shot No.	Analog Tape No.	CH-2 Gain db	Digital Tape No.	CONRAD SOA knots	Shot Size lb.	REMARKS
1	6B	31	9	9	2	MISSED
2-3						CAP
4						PARTIAL
5-12						GOOD
13			10			CAP
14-17						GOOD
18		34				GOOD
19						PARTIAL
20-24						GOOD
25	7B					CAP
26						PARTIAL
28-31						GOOD
32						CAP
33-34						GOOD
35					3	GOOD
36-39						GOOD
40-43						CAP
44-46						GOOD
47		40				PARTIAL
48						GOOD
49			11			
50-51		46				GOOD
52						CAP

Shot No.	Analog Tape No.	CH-2 Gain db	Digital Tape No.	CONRAD SOA knots	Shot Size lb.	REMARKS
53-62						GOOD
63						CAP
64-65						GOOD
66						GOOD Range 40,000 yds
67						PARTIAL
68						GOOD
69		47				CAP
70-71						PARTIAL
72-73		46				GOOD
74-80	8B					GOOD
81						CAP
82-84						GOOD
85			12			GOOD
86-87						GOOD
88-92		52				GOOD
93-99		58				GOOD

TABLE 6

Track-3 Closing

Bearing 240 Degrees True

Shot No.	Analog Tape No.	CH-2 Gain db	Digital Tape No.	CONRAD SOA knots	Shot Size lb.	REMARKS
1-20	9B	58	12	9	3	GOOD
21			13			GOOD
22-25						GOOD
26		52				GOOD
27-28		46				GOOD
29						GOOD Range 50,000 yds
30-32						GOOD
33	10B					GOOD
34						GOOD Range 40,000 yds
35						GOOD
36						PARTIAL
37-41						GOOD
42						PARTIAL
43						GOOD
44-49		52				GOOD
50						PARTIAL
51						GOOD
52						PARTIAL
53-54						CAP
55-56						GOOD
57		49				GOOD
58						CAP
59-62			14			GOOD

Table 6 (cont)

Shot No.	Analog Tape No.	CH-2 Gain db	Digital Tape No.	CONRAD SOA knots	Shot Size lb.	REMARKS
63						CAP
64						CAP
65		39				GOOD Range 20,000 yards
66						PARTIAL
67-68						GOOD
69		36			2	GOOD
70						CAP
71-72						GOOD
73						CAP
74-78						GOOD
79						CAP
80						GOOD
81	11B					GOOD
82						GOOD
83-93		33				GOOD
94		30	15	4.5		GOOD
95-98						GOOD
99-113		27				GOOD

TABLE 7

Track-1 Deep Explosives

Bearing 0 Degrees True

Shot No.	Station No.	Range Yds	Angle Est.	Analog Tape	Posit (Approx)
1	5	7850	30	3A	1.6 mi NE
2	5	7850	30	3A	2.0 mi NE
3	5	7850	30	3A	2.0 mi NE
8	6	8600	27.5	4A	1.6 mi SE
10	6	8600	27.5	4A	1.6 mi SE
12	7	9500	25	5A	1.8 mi SE
13	7	9500	25	5A	1.8 mi SE
14	7	9500	25	5A	1.8 mi SE
15	7	9500	25	5A	1.8 mi SE
17	8	10600	22.5	6A	2.0 mi S
18	8	10600	22.5	6A	2.0 mi S
20	8	10600	22.5	6A	2.0 mi S
22	9	11800	20	7A	2.0 mi S
27	10	13000	18	8A	2.0 mi S
30	10	13000	18	8A	2.0 mi S
31	11	14400	16	9A	5.2 mi W
35	11	14400	16	9A	5.2 mi W
42	12	16000	14	2B	5.0 mi W
46	13	18000	12	3B	5.0 mi W
57	14	20400	10	5B	1.0 mi S
66	15	23300	8	6B	1.1 mi S
67	16	26800	6	7B	1.3 mi S